

these operating modes, a net decrease in NO emissions is found.

The next section presents results for tandem dump trucks with Tier 1 engines.

### **8.3 Double Rear Axle (Tandem) Dump Trucks - Tier 1 (Petroleum Diesel / B20 Biodiesel)**

In this section, the typical duty cycles, fuel consumption and emission rates, and comparison of fuel consumption and emissions for B20 biodiesel versus petroleum diesel are presented. The previous section provided a detailed discussion regarding the interpretation of these data. It is assumed that the reader has read the previous section. Therefore, this section will be more brief in that it will highlight any key differences with respect to the insights obtained based upon the single rear axle vehicles with Tier 1 engines. These insights include the following:

- There is significant variability in fuel consumption and emissions among the operating modes
- The trends of emissions among the operating modes differ among the pollutants.
- There is inter-vehicle variability in fuel use and emissions, some of which is related to operating conditions (e.g., duty cycle, load)
- Fuel use and emissions are higher for loaded versus unloaded operations.
- Typically, fuel use and CO<sub>2</sub> emissions are comparable or slightly higher for B20 biodiesel versus petroleum diesel fuel.
- Typically, for the single-rear axle dump trucks with Tier 1 engines, emissions of NO, HC, CO, and PM are lower for B20 biodiesel versus petroleum diesel. However, for the tandem dump trucks with Tier 1 engines, the emissions of CO and PM did not change significantly, on average. The emissions of NO and HC decreased significantly.

The average duty cycles for unloaded and loaded tandems are shown in Figure 8-4 for petroleum diesel and Figure 8-5 for B20 biodiesel. There is some variability in the activity patterns. For example, the amount of time spent idling was only 25 percent for loaded vehicles fueled with petroleum diesel but was as high as 60 percent for unloaded vehicles fuel with petroleum diesel or for loaded vehicles fueled with B20 biodiesel. The distribution of operating mode by distance was approximately similar for the tandems as for the single rear-axle trucks, with a large contribution from the high cruise mode. Similarly, the contribution of the acceleration modes to fuel consumption, and to emissions, was generally in greater proportion than the contribution of these modes to either time or distance of the duty cycles. The CO<sub>2</sub> and fuel consumption distributions were similar. HC and CO emissions tended to have a larger contribution from low power demand modes such as idle, dumping, low acceleration, and low cruise, than did the NO emissions. To a first approximation, the distribution of emissions of any of the pollutants is comparable to the distribution of fuel consumption by mode. However, as shown by data given in the appendix, there is significant variability in emission rates even on a mass per gallon of fuel consumed basis.

Tables 8-6 and 8-7 provide results for the modal emission rates by vehicle and load, for petroleum diesel and for B20 biodiesel, respectively. Table 8-8 summarizes the ratio of fuel use